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(54) Motor vehicle transmission  
mechanism

(57) A motor vehicle transmission has an input shaft (2), an output shaft (3) and at least four gear trains (6—R, 6—1, 6—2, 6—3 . . .) that can be selectively connected between the shafts (2, 3) through clutches (7—1, 7—2 . . .). At least one of the clutches (7—1) is common to two of

the gear trains (6—R, 6—3). These two gear trains are selectively connected between the shafts (2, 3) through their common clutch (7—1) by operation of a selection mechanism (8—1), and are differentiated in speed stage from one another by three stages. In the case of power transmission through any selected gear train (6—1, 6—2) other than said two gear trains (6—R, 6—3), that one of these two gear trains (6—R, 6—3) that has its speed stage nearer the speed stage of the selected gear train (6—1 or 6—2) is placed in readiness for connection between the two shafts (2, 3) by operation of the selection mechanism (8—1). As a result rapid change from one gear train to the next can be effected. In a five forward speed transmission, second and fifth speeds may also have a common clutch.

FIG. 3

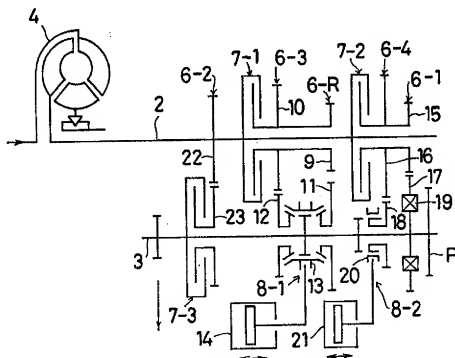


FIG. 1

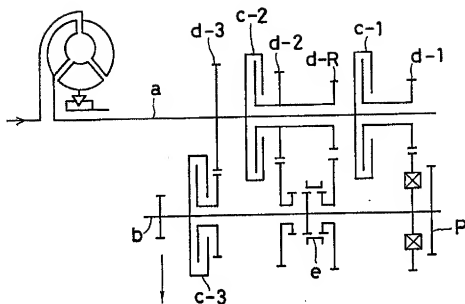


FIG. 3

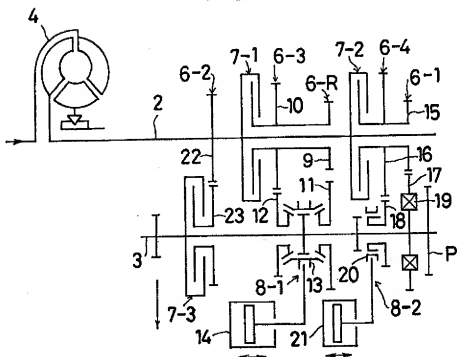


FIG. 2

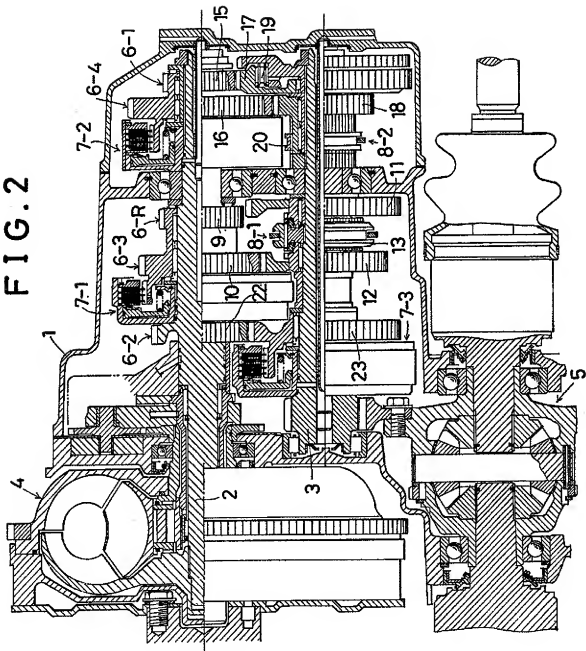


FIG. 4

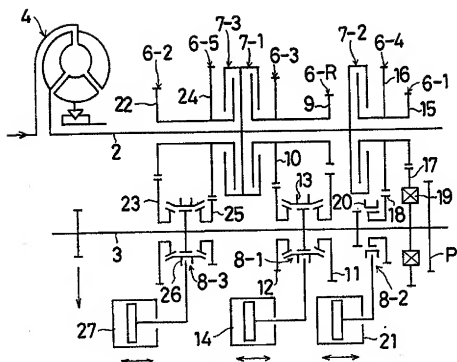


FIG. 5

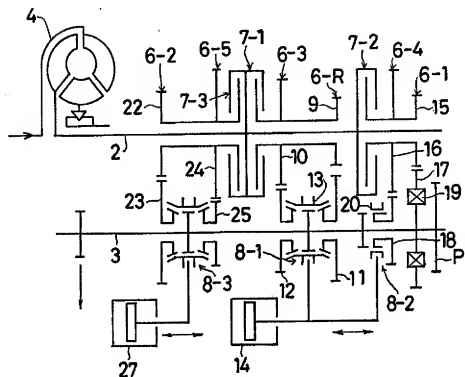
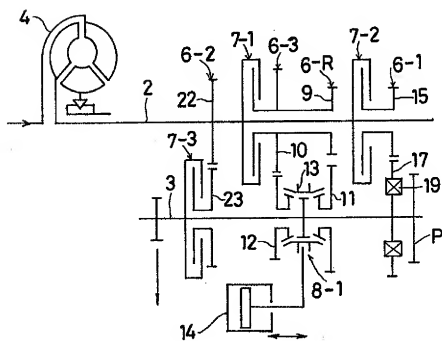


FIG. 6



## SPECIFICATION

## Motor vehicle transmission mechanism

This invention relates to motor vehicle transmission mechanism wherein gear trains for different speed stages are selected to be effective, by operation of respective clutches, between an input shaft connected to an internal combustion engine and an output shaft connected to a driving road wheel.

In Figure 1 of the accompanying drawings there is shown, diagrammatically, a known transmission mechanism having four gear trains d—R, d—1, d—2, d—3 for a reverse stage and three forward stages respectively disposed between an input shaft a and an output shaft b, these gear trains being selected to be effective by operation of clutches c—1, c—2 and c—3 for the trains d—1, d—2 and d—3 respectively, the clutch c—2 for the second speed gear train d—2 (forward intermediate speed stage) in addition serving as a clutch for the reverse gear train d—R. Selection of the gear train d—2 or d—R to be operative, through their common clutch c—2, is achieved by operation of a selection mechanism e provided separately therefrom. In this way a minimising of the axial directional size of the transmission mechanism as a whole is achieved by omitting a clutch for exclusive use of reverse driving and it becomes possible to mount the transmission mechanism in a small-sized front-engine front-wheel-drive motorcar in which the space available for mounting a transmission mechanism is limited.

In Figure 1, P denotes a gear for locking the transmission mechanism for parking.

To decrease the number of clutches by omitting a clutch for exclusive use for reverse driving is advantageous not only in minimising axial length, but also in minimising the weight of the apparatus, and in decreasing the total amount of torque loss caused by clutch dragging phenomenon. However, the known mechanism just described is inconvenient in that when the selection mechanism e is changed over to obtain reverse driving and the common clutch c—2 is engaged to effect the reverse driving, a friction plate on the input side of the clutch c—3 for the third speed gear train (forward high speed stage) is rotated at high speed in accordance with rotation of the input shaft a through the third speed gear train d—2, that is relative rotation of the input side friction plate to a friction plate on the output side of the clutch c—3 that is rotated together with the output shaft b becomes very high, and thereby torque loss caused by dragging phenomenon is increased. This torque loss problem has to be taken into consideration also in such a case that the number of forward speed stages is increased to four stages or five stages with a common use of clutches for these forward gear trains, and also in this case consideration has to be given to the influence on running characteristics of the vehicle of a time lag that occurs when the gear trains are selectively changed-over by operation of a selection mechanism.

According to the present invention there is provided a motor vehicle transmission mechanism having an input shaft for connection to an internal combustion engine, an output shaft for connection to a driving road wheel of a vehicle, and at least four gear trains of different speed stages that can be selectively connected between the two shafts through clutches, at least one of the clutches being common to two of the gear trains, and these two gear trains being selectively connected between the two shafts through their common clutch by operation of a selection mechanism provided separately from the common clutch, these two gear trains being differentiated in speed stage from one another by three stages, and being so arranged that, in case of power transmission through any selected gear train other than these two gear trains, that one of the two gear trains that has its speed stage nearer the speed stage of the selected gear train is placed in readiness for connection between the two shafts by operation of the selection mechanism. In this mechanism, the number of clutches, and hence the size and weight of the mechanism, is minimised, and in addition rapid speed changes can be effected with consequent good effects on driving characteristics. Torque loss caused by dragging phenomenon is also minimised with consequent good fuel consumption characteristics.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the remaining Figures of the accompanying drawings, in which:—

Figure 2 is a sectional side view of a motor vehicle transmission mechanism,  
Figure 3 is a diagrammatic illustration of the mechanism of Figure 2, and  
Figures 4, 5 and 6 are illustrations, similar to Figure 3, of further forms of transmission mechanism.

Referring first to Figures 2 and 3, numeral 1 denotes a transmission casing, and numerals 2 and 3 denote an input shaft and an output shaft provided in the casing 1 in parallel with one another. The input shaft 2 is connected to an internal combustion engine through a torque converter 4, and the output shaft 3 is connected to driving road wheels of the vehicle through a differential gear 5. A reverse gear train 6—R and four forward gear trains 6—1, 6—2, 6—3, 6—4 are disposed between the two shafts 2, 3. The two gear trains 6—R, 6—3 for reverse and third speed which are differentiated by three stages from one another, are connected to a first, common, clutch 7—1. Similarly the two gear trains 6—1, 6—4 for the first speed and the fourth speed, which are also differentiated by three stages from one another, are connected to a second, common, clutch 7—2. The clutches 7—1 and 7—2 are mounted on the input shaft 2. On the output shaft 3 there are mounted a first selection mechanism 8—1 interposed between the two gear trains 6—R and 6—3, and a second selection mechanism 8—2

interposed between the two gear trains 6—1 and 6—4.

In more detail, the reverse gear train 6—R and the third speed gear train 6—3 have respective driving gears 9, 10 mounted on the input shaft 2 and respective driven gears 11, 12 mounted on the output shaft 3. The two driving gears 9, 10 are combined together into a unit associated with the first, common, clutch 7—1. The two driven gears 11, 12 are selectively connected to the output shaft 3 for rotation therewith through the first selection mechanism 8—1 interposed between these two gears 11, 12 and the output shaft 3 so that only the gear train 6—R or 6—3 that has its driven gear 11 or 12 selected by the selection mechanism 8—1 is made operative between the input and output shafts 2 and 3.

The first selection mechanism 8—1 comprises a synchromesh mechanism having a shift gear 13 for selectively connecting the gear 11 or 12 to the output shaft 3 and is so operable. In conjunction with a first servo means 14 shown in Figure 3, as to be changed over between a rightward (in the Figures) reverse driving position in which the reverse gear train 6—R is selected and a leftward (in the Figures) third speed driving position in which the third speed gear train 6—3 is selected.

An idler gear not illustrated is interposed between the driving gear 9 and the driven gear 11 of the reverse gear train 6—R.

The first speed gear train 6—1 and fourth speed gear train 6—4 have respective driving gears 15, 16 mounted on the input shaft 2 and respective driven gears 17, 18 mounted on the output shaft 3. The driving gears 15, 16 form a unit associated with the output side of the second, common, clutch 7—2.

This arrangement is not significantly different from that of the reverse driving gear train 6—R and third speed gear train 6—3 as described above. In this case, however, the second selection mechanism 8—2 includes a one-way clutch 19 interposed between the first speed driven gear 17 and the output shaft 3 for allowing over-running of the output shaft 3, and a shift gear 20 interposed between the fourth speed driven gear 18 and the output shaft 3, so that under the condition that the shift gear 20 is operated to be changed-over from a rightward (in the Figures) first speed position to a leftward fourth speed position in conjunction with movement of a second servo means 21 (Figure 3), and thereby the fourth speed driven gear 18 is connected to the output shaft 3, the connection between the first speed driven gear 17 and the output shaft 3 is substantially cut-off by the action of the one-way clutch 19.

The second speed gear train 6—2 has a driving gear 22 fixed to the input shaft 2 and a driven gear 23 mounted on the output shaft 3 for connection to the shaft 3 for rotation therewith by operation of a third clutch 7—3 mounted on the output shaft 3. Thus this gear train 6—2 is made effective between the input shaft 2 and the output shaft 3 by operation of the third clutch 7—3.

The first, second and third clutches 7—1, 7—2 and 7—3 and the first and second servo means 14 and 21 may be oil pressure operated or electro-magnetically operated, operated as described below in conjunction with a related operation of a selection lever (not illustrated) that can be shifted, for instance, to a P position for parking, an R position for reverse driving, an N position (neutral) and a D position for forward running with automatic speed changes. The operation of the mechanism in these various selection lever positions will now be described.

#### *P position or N position.*

If the selection lever is the P position or the N position, the first selection mechanism 8—1 is set in its reverse driving position by the first servo means 14, and the second selection mechanism 8—2 is set in its first speed position by the second servo means 21, so that there are placed in readiness for being operative the reverse driving gear train 6—R, the first speed gear train 6—1, and the second speed gear train 6—2. In this case, however, the respective clutches 7—1, 7—2, 7—3 are all released, so that no gear train is operative and therefore there is no power transmission between the two shafts 2 and 3. In the P position, a pawl mechanism not illustrated is brought into engagement with the parking gear P for holding the vehicle in its parked state.

#### *R position*

If the selection lever is shifted to its R position, conditions are as in the N position with the difference that the first clutch 7—1 is engaged so that reverse driving results from power transmission through the reverse driving gear train 6—R.

#### *D position*

If the selection lever is shifted to its D position, firstly the second clutch 7—2 is engaged under the same condition as in the N position for effecting forward driving under power transmission through the first speed gear train 6—1, and then, by means of a control circuit giving an automatic shift, the third clutch 7—3 is engaged for effecting forward driving under power transmission through the second speed gear train 6—2.

It is to be noted here that at second speed stage driving, the first selection mechanism 8—1 is changed over to its third speed position by the first servo 14, and thereby the third speed gear train 6—3 (which, of the two gear trains 6—R, 6—3 having the common clutch 7—1, is the one having the speed stage that is nearer the speed stage of the second speed gear train 6—2) is placed in readiness for operation, in place of the reverse driving gear train 6—R. Thus if the first clutch 7—1 is engaged,

there is immediately effected forward driving at the third speed stage by power transmission through the third speed gear train 6—3.

Upon third speed stage driving, the second selection mechanism 8—2 is changed over to its fourth speed position by the second servo means 21, and thereby the fourth speed gear train 6—4 (which of the two gear trains 6—1, 6—4 having the common clutch 7—2, is the one having the speed stage which is nearer that of the third speed gear train 6—3) is placed in readiness for operation, in place of the first speed gear train 6—1. In this situation, therefore, if the second clutch 7—2 is engaged, there is effected immediately forward driving at the fourth speed stage by power transmission through the fourth speed gear train 6—4.

The foregoing operations can be summarised as shown in the following Table 1, in which clutches engaged and gear trains operative or in readiness for operation are identified by the symbol "O".

TABLE 1

Selection Lever Position	Clutch			Gear Train				Parking Gear
	first	second	third	Reverse	first	second	third	fourth
P	I	I	I	O	O	O	I	I
N	I	I	I	O	O	O	I	I
R	O	I	I	O	O	O	I	I
D	first speed	I	I	O	O	O	I	I
	second speed	I	O	I	O	O	O	I
	third speed	O	I	I	I	O	O	I
	fourth speed	I	I	I	I	O	O	I

As will be clear from Table 1, when any gear train is operative, that gear train of the other two gear trains that have a common clutch, or that gear train of each pair of gear trains that have a common clutch, which is the gear train having its speed stage nearer that of the operative gear train, is placed in readiness for operation, so that a rapid change from one gear train to the next effected by changing-over of clutches, can be achieved without time lag produced by a change-over of the selection mechanism 8—1 or 8—2. Furthermore, as the second speed stage and the third speed stage are ready to be operated when it is the fourth gear train that is transmitting power, it will be appreciated that it is possible to make a rapid so-called "kick-down" operation from the fourth speed stage to the third speed stage or further to the second speed stage.

Torque loss caused by dragging phenomenon of each of the clutches connected to the two gear trains that are ready to be operated is minimised because the relative rotation speed between the input side and the output side of each of these clutches is small as these two gear trains have speed stages which are the nearer to the speed stage of the gear train that is serving to transmit power, and this effect is enhanced by the minimisation in the number of clutches utilised. This torque loss is minimised even though four forward speed stages are provided.

The reason that the first selection mechanism 8—1 is a synchromesh mechanism is to achieve a synchronous meshing thereof with the respective driven gears 11 and 12 for rearward driving and third speed driving, which gears rotate in mutually opposite directions at the time of changing-over operation for shifting between second speed and first speed. Thereby, there can be prevented generation of meshing noise as would be caused on meshing if this mechanism 8—1 were not a synchromesh mechanism.

The transmission mechanism of Figure 4 has one reverse gear train 6—R and five forward gear trains 6—1, ... 6—5. The two gear trains 6—2, 6—5 for second speed and fifth speed have their respective driving gears 22, 24 mounted as a unit on the input shaft 2. This unit is associated with a third clutch 7—3 mounted on the input shaft 2. Respective driven gears 23, 25 of these trains 6—2, 6—5, mounted on the output shaft 3, are selectively connected to the output shaft 3 for rotation therewith through a third selection mechanism 8—3. The remaining parts of this mechanism are not significantly different from the mechanism of Figures 2 and 3. The third selection mechanism 8—3 is a synchromesh mechanism having a shift gear 26, and is operated to change over from a leftward (in the Figure) second speed position to a rightward fifth speed position (and back) by a third servo means 27. The third clutch 7—3 and the first clutch 7—1 are parts of a double clutch of which an outer is common to the clutches 7—3 and 7—1 so that the axial directional length of the transmission mechanism is minimised.

As for the transmission mechanism of Figures 2 and 3, the operation of that of Figure 4 can be summarised in a table as follows:—

TABLE 2

Selection Lever Position	Clutch			Gear Train						Parking Gear
	first	second	third	reverse	first	second	third	fourth	fifth	
P	—	—	—	O	O	O	—	—	—	O
N	—	—	—	O	O	O	—	—	—	—
R	O	—	—	O	O	O	—	—	—	—
D	first speed	—	—	O	O	O	—	—	—	—
	second speed	—	O	—	O	O	O	—	—	—
	third speed	O	—	—	—	O	O	O	—	—
	fourth speed	—	—	—	—	—	O	O	O	—
	fifth speed	—	O	—	—	—	O	O	O	—

It will be clear from Table 2 that no matter which gear train is operative, that gear train, of each pair of gear trains that have a common clutch, which is the gear train of the pair having its speed stage nearer that of the operative gear train, is placed in readiness for operation, giving rapid gear changes as discussed above.

5 Figure 5 shows a modified form of the transmission mechanism of Figure 4. In this form, the second selection mechanism 8—2 is operated by the first servo means 14, which, in addition, operates the first selection mechanism 8—1, thereby simplifying the control mechanism. The operation of this mechanism is shown in Table 3, as follows:— 5

TABLE 3

Selection Lever Position	Clutch			Gear Train					Parking Gear
	first	second	third	reverse	first	second	third	fourth	fifth
P	—	—	—	O	O	O	—	—	O
N	—	—	—	O	O	O	—	—	—
R	O	—	—	O	O	O	—	—	—
D	first speed	—	—	O	O	O	—	—	—
	second speed	—	O	—	—	O	O	O	—
	third speed	O	—	—	—	O	O	O	—
	fourth speed	—	—	—	—	—	O	O	O
	fifth speed	—	O	—	—	—	O	O	O

The difference in operation set out in Table 3, as compared with Table 2, is that in conjunction with the operation that, in second speed driving, the first selection mechanism 8—1 is changed over to the leftward third speed position by the first servo means 14, the second selection mechanism 8—2 is also changed over to the leftward fourth speed position, and thereby the fourth speed gear train 6—4 is placed in readiness for operation (instead of the first speed gear train) and it becomes impossible to kick-down from the second speed to the first speed. However, in a transmission mechanism with five forward speeds, the speed stage of the second speed gear train 6—2 has such a considerably low ratio that kick-down operation from the second speed to the first speed is unnecessary in practical use. When shift-down operation from the second speed to the first speed is effected in accordance with reduction in vehicle speed, the first servo means 14 is, firstly, moved to the right (in the Figure) and thereafter the third clutch 7—3 is released and the second clutch 7—2 is engaged. As a result there is a time lag, but it is satisfactory if this shift-down operation is completed just before the vehicle stops, for example at a street crossing, and there is enough time to achieve this so there is no problem in practical use.

As is clear from Table 3, so far as the reverse, first, third, fourth and fifth gear trains are concerned, no matter which of these gear trains is operative, that gear train, of each pair of gear trains that have a common clutch, which is the gear train of the pair having its speed stage nearer that of the operative gear train, is placed in readiness for operation. It is also the case that when the second gear train is operative there is one pair of gear trains (the trains 6—R, 6—3) that have a common clutch (the clutch 7—1) in which it is that gear train (the train 6—3) that has its speed range nearer to that of the gear train 6—2 that is placed in readiness for operation. Rapid change from second to third speed is therefore achievable in the manner described above.

Explanation has so far been made with reference to the case where completely automatic operation takes place with the selection lever set in its D position, but the constructions described are applicable to a semi-automatic transmission mechanism in which speed change is effected by discrete movements of the selection lever.

Furthermore, the transmission mechanism of Figure 6 is one in which there is one reverse stage and three forward stages, obtained by omitting the fourth speed gear train 6—4 of the form shown in Figures 2 and 3. Alternatively, one reverse stage and six forward stages, with four clutches, can be provided.

In the transmission mechanisms described with reference to the drawings, minimisation of size and weight is obtained by minimum use of clutches, achieved by a common use of clutches. Furthermore, whichever gear train is selected for power transmission there is at least one pair of gear trains having a common clutch of which trains that having its speed stage nearer to that of the selected gear train is placed in readiness for operation, and as a result rapid speed change from the selected gear train to this train can be effected, enhancing drivability. Torque loss caused by dragging phenomenon of each of the clutches connected to these two gear trains is minimised as much as possible by the fact that it is the nearer, in terms of speed stage, of the two gear trains that is placed in readiness for operation and this, coupled with a minimal use of clutches, minimises torque loss and hence gives good fuel consumption characteristics.

#### 40 CLAIMS

1. A motor vehicle transmission mechanism having an input shaft for connection to an internal combustion engine, an output shaft for connection to a driving road wheel of a vehicle, and at least four gear trains of different speed stages that can be selectively connected between the two shafts through clutches, at least one of the clutches being common to two of the gear trains, and these two gear trains being selectively connected between the two shafts through their common clutch by operation of a selection mechanism provided separately from the common clutch, these two gear trains being differentiated in speed stage from one another by three stages, and being so arranged that, in case of power transmission through any selected gear train other than these two gear trains, that one of the two gear trains that has its speed stage nearer the speed stage of the selected gear train is placed in readiness for connection between the two shafts by operation of the selection mechanism.

2. A transmission mechanism as claimed in claim 1, wherein there is a reverse gear train, a first speed gear train, a second speed gear train, a third speed gear train and a fourth speed gear train; wherein there is a first clutch that is common to the reverse gear train and the third speed gear train and a second clutch that is common to the first speed gear train and the fourth speed gear train; and wherein there is a first selection mechanism that co-operates with the first clutch and a second selection mechanism that co-operates with the second clutch.

3. A transmission mechanism as claimed in claim 1, wherein there is a reverse gear train, a first speed gear train, a second speed gear train, a third speed gear train, a fourth speed gear train and a fifth speed gear train; wherein there is a first clutch that is common to the reverse gear train and the third speed gear train, a second clutch that is common to the first speed gear train and the fourth speed gear train and a third clutch that is common to the second speed gear train and the fifth speed gear train; and wherein there is a first selection mechanism that co-operates with the first clutch, a second selection mechanism that co-operates with the second clutch and a third selection mechanism that co-operates with the third clutch.

4. A transmission mechanism as claimed in claim 3, wherein the first selection mechanism and the second selection mechanism move in conjunction with one another.

5. A transmission mechanism as claimed in claim 1, wherein there is a reverse gear train, a first speed gear train, a second speed gear train and a third speed gear train, and wherein there is a clutch that is common to the reverse gear train and the third speed gear train.

6. A transmission mechanism as claimed in claim 2 or 3, wherein the first selection mechanism is a synchromesh mechanism.

7. A transmission mechanism as claimed in claim 2, 3 or 6, wherein the second selection mechanism includes a one-way clutch interposed between a driven gear of the first speed gear train and the output shaft, and a shift gear interposed between a driven gear of the fourth speed gear train and the output shaft.

8. A transmission mechanism as claimed in claim 3, or either of claims 6 and 7 as appendant to claim 3, wherein the third selection mechanism is a synchromesh mechanism.

9. A transmission mechanism as claimed in claim 3, or either of claims 6 and 7 as appendant to claim 3, or claim 8, in which the first clutch and the third clutch are parts of a double clutch of which an outer is common to the first clutch and the third clutch.

10. A motor vehicle transmission mechanism substantially as hereinbefore described with reference to Figures 2 and 3, or Figure 4, or Figure 5, or Figure 6 of the accompanying drawings.